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PATENT APPLICATION

of

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**METHOD AND APPARATUS FOR PRODUCING
RINGING TONES IN A COMMUNICATION DEVICE**

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**METHOD AND APPARATUS FOR PRODUCING RINGING
TONES IN A COMMUNICATION DEVICE**

Field of the Invention

5 The present invention is generally related to the making of a ringing tone in a communication device for signaling an incoming telephone call or indicating the reception of a message.

Background of the Invention

10 In an old styled telephone set, the ring tone that is used to signal an incoming telephone call is usually produced by a ringer repeatedly striking one or two bells. In a mobile phone, the ringing tone is produced by an electronic buzzer, which produces a pitch of a given frequency according to a value in a data stream representative of a series of musical tones.

15 Electronically producing music is well known in the art. For example, U.S. Patent No. 5,753,843 (Fay) discloses a system and process for composing a musical section in response to a user's interaction with a multimedia presentation. As disclosed in Fay, the system includes a composition engine, a performance engine and an arbitrator. The arbitrator provides an interface with an application program running a multimedia
20 presentation. The arbitrator receives parameters from the application program indicative of the user's interaction and the type of music the application program requested in response to the user's interaction. The parameters are passed to the composition engine, which composes a musical section having a chord progression and other data therein. The musical section and the style provided by the arbitrator are used by the performance
25 engine to generate music sequence data for driving a musical instrument. The performance of the musical sequence data by the musical instrument occurs substantially contemporaneously with the user's interaction, which causes the composition of the musical section. The composition engine performs a plurality of functions to compose musical sections, wherein the functions are implemented by a musical template generator and a musical section generator. In the musical template generator, the process of
30 template generation begins by invoking a signpost creation process, which places signpost chord markers in an empty template data structure. After the signpost chord markers have

been placed in the template, a second process is invoked to provide embellishment commands in the template. The template is then passed to the musical section generator to add musical content to the template. The musical section generator uses a template retrieved from a data storage to compose the musical section. As disclosed, the method
5 for producing musical sections is based on stored data in combination with a "personality", which is a data structure for defining a mood. In order to carry out such a method, a large data storage area is necessary for storing all the templates, and a powerful computer is necessary for data processing. As disclosed in Fay, the required computer system has a least an INTEL 386SX processor with at least two megabytes of RAM and at
10 least five megabytes of disc storage space. Thus, while the selection of chords and the selection of personality are useful for a multimedia presentation, they are impractical for generating ringing tones in a small communication device, such as a telephone.

U.S. Patent No. 5,452,354 (Kyrölähti et al.) discloses a ringing tone apparatus, wherein subscriber identification information is used to generate the ringing tone. As
15 disclosed in Kyrölähti et al., a ringing tone can be generated based on two or more binary digits of the subscriber identification number such as the mobile station identification number (MSIN), mobile identification number (MIN), etc. For example, if the lowest bits of the identification MSIN are described as a string of 11 binary digits D10-D9-D8-D7-D6-D5-D4-D3-D2-D1-D0, this string of digits can be used to specify the parameters
20 necessary for generating a ringing tone as follows: D1 and D0 are used to determine the duration of each ringing tone pulse; D3 and D2 are used to determine the frequency of the ringing tone pulses; D5 and D4 are used to determine the pulse number in one pulse sequence; D7 and D6 are used to determine the number of sequences to be repeated in the ringing tone; and D10, D9 and D8 are used to determine the silence period between pulse
25 sequences. While this tone generation method is useful for producing different ringing tones for different subscribers, the ringing tones may sound too mechanical and may contain musical notes that are not pleasing when played together.

Thus, it is desirable to provide a method to produce a vast range of plausible and pleasing telephone ringing tones, wherein the ringing tones are randomly produced so as
30 to allow a user to select a different ringing tone to signal an incoming telephone call or to indicate the reception of a voice or data message.

Summary of the Invention

The first aspect of the present invention is a method of producing a ringing tone to be used in a communication device, such as a telephone, an electronic organizer or a personal digital assistant (PDA), wherein the ring tone is representable by a plurality of musical notes. The method comprises the steps of:

generating a sequence of musical notes, wherein each note has a pitch and a duration;

modifying the sequence according to a set of modification rules regarding the pitch and the duration of the musical notes within the sequence for producing a modified sequence; and

repeating the modified sequence a number of times for forming a string of musical notes indicative of the ringing tone.

Preferably, these steps are initiated by a user via an initiation signal, wherein the initiation signal is provided by an activation device.

Preferably, the pitch of at least one note is randomly assigned within a range of musical tones, and the duration of at least one note is randomly assigned within a range of note duration in response to the initiation by the user for producing a motif in a substantially random fashion.

Preferably, the sequence has a length represented by a number of notes, wherein the note number is randomly assigned within a range of positive integers.

Preferably, the method also comprises the step of modifying the sequence according to at least one of the modification rules, wherein the plurality of modification rules include:

a) eliminating identical pitches occurring in adjacent notes by way of pitch replacement;

b) modifying the duration of the notes in a random fashion in order to produce a non-mechanical playing effect;

c) shortening the duration of the notes in order to produce a non-legato or staccato playing effect;

d) correcting a tonal interval between adjacent notes by way of pitch replacement

if the tonal interval is a tritone or a seventh;

e) changing the pitch of the notes if the pitch is equivalent to one of the black keys on a piano;

f) changing a note into a series of trills if the duration of the note is equal to or
5 greater than a pre-determined value; and

g) changing the pitch of a note according to the relative placement of that note in the sequence.

It is possible that the duration of one note in the sequence is different from the duration of other notes in the sequence.

10 It is possible that the duration of all the notes in the sequence is the same.

Preferably, the method further comprises the steps of:

storing digital data indicative of the sequence of musical notes in a computer-readable medium;

15 retrieving the digital data from the computer-readable medium prior to modifying the sequence so as to allow the modifying step to produce the modified sequence based on the digital data;

storing further digital data indicative of the modified sequence in the computer-readable medium;

20 retrieving the further digital data from the computer-readable medium prior to repeating the modified sequence so as to allow the repeating step to form the string of musical notes based on the further digital data; and

converting the further digital data into an audio form indicative of the ringing tone.

25 Preferably, the motives so generated at the initiation by the user can be stored in a memory unit of the communication device so as to allow the user to choose a ringing tone for signaling an incoming telephone call or indicating the reception of a voice or data message. The user can choose a different ringing tone for signaling a different event, if so desired. Furthermore, the user can decide to delete or to keep a ringing tone that is produced in response to the user activating the switch. The user can also delete one or
30 more modified sequences stored in the computer-readable medium and generate new ones, if so desired.

The second aspect of the present invention is an apparatus for providing a ringing tone for storage in a communication device, wherein the ringing tone is representative of a plurality of musical notes defined by pitch and duration and the ringing tone is provided in response to an initiation signal provided by a user. The apparatus comprises:

5 a mechanism, responsive to the initiation signal, for generating a sequence of musical notes and for providing a first signal indicative of the sequence of musical notes, wherein each note has a pitch and a duration;

 a mechanism, responsive to the first signal, for modifying the sequence according to a set of modification rules regarding the pitch and the duration of the musical notes
10 within the sequence for producing a modified sequence, and for providing a second signal indicative of the modified sequence; and

 a mechanism, responsive to the second signal, for repeating the modified sequence a number of times for forming a string of musical notes indicative of the ringing tone.

 Preferably, the device also includes a computer-readable medium and
15 a mechanism, responsive to the string of musical notes, for providing digital data indicative of the musical notes;

 a mechanism, responsive to the digital data, for storing the digital data in the computer-readable medium;

 a mechanism, responsive to the initiation signal, for retrieving the digital data
20 from the computer-readable medium; and

 a mechanism for converting the retrieved digital data in to an audible form indicative of the ringing tone.

The third aspect of the present invention is a communication device, such as a mobile phone, an electronic organizer or a personal digital assistance, which comprises:

25 a mechanism, responsive to an event in the communication device, for producing an event signal;

 a computer-readable medium for storing digital data of a sequence of musical notes defined by pitch and duration, wherein the pitch and the duration of the musical notes are chosen in a random fashion but modified according to a set of modification rules
30 regarding the pitch and the duration of the musical notes within said sequence so as to make a modified sequence, and wherein the modified sequence is repeated a number of

times so as to form a repeated sequence;

means, responsive to the event signal, for retrieving the digital data from the computer-readable medium;

means, responsive to the retrieved digital data, for converting the digital data into
5 a further signal; and

a sound producing device, responsive to said further signal, for providing a ringing tone indicative of the retrieved digital data.

The present invention will become apparent upon reading the description taken in conjunction with Figures 1 to 4.

Brief Description of the Drawings

Figure 1 is a diagrammatic illustration showing a communication device capable of producing a ringing tone.

Figure 2 is a flow chart illustrating the steps in producing the ring tone.

Figure 3 is a flow chart illustrating the steps of producing a motif.

Figure 4 is a computer program illustrating the generation of a motif according to the Mecano-style.

Detailed Description

Figure 1 shows a communication device, such as a personal digital assistant (PDA) or a mobile phone 10, which has an antenna 20 for communication purposes. The communication device 10 has a display 22 for displaying communication messages, and a signal/data processor 30 for processing communication signals received or transmitted via the antenna 20. The communication device 10 further comprises a storage medium 40 for storing digital data 42 and software 44. The software 44 includes a computer program for generating a sequence of musical notes, wherein each note has a pitch and a duration, and modifying the sequence according to a set of modification rules. An exemplary computer program is shown in Figure 4. The modified sequence can be repeated a number of times to form a string of music notes, or motif, indicating a ringing tone. The sequence of musical notes can be stored in the storage medium 40 as part of the digital data 42. Preferably, the motif is generated at the initiation by a user who activates an active switch

32. The generated motif can also be stored in the storage medium 40 as part of the digital data 42. More than one motif can be generated and stored as that the user can choose a ringing tone for signaling an incoming phone call, indicating an incoming email or voice message, or reminding the user of a forthcoming event as stored in the storage medium 40. For example, when an incoming phone call is received by the call receiver 34, a data retriever 50 retrieves one of motives stored in the storage medium 40 for producing a first signal indicative of the retrieved motif. A data converter 52, responsive to the first signal, converts the retrieved motif into an analog form to be conveyed to a sound producing device 54, which provides an audible form indicative of the ringing tone. The major feature of the present invention is that the ringing tone, as produced by the communication device 10, is not a fixed pattern that is pre-stored in the storage medium 40, nor is it selected from a plurality of fixed patterns stored in the storage medium 40. Rather, the ringing tone is generated at the initiation of a user who activate an activation device or switch 32 to start the motif generation process. The algorithm for the motif generation software 44 is designed such that the motif generated at one time is very unlikely to be identical to the motif generated at another time. If the user prefers keeping the generated motif as a ringing tone, the user can store the motif for future use. Otherwise the user can delete the generated motif. The user can also delete one or more motives stored in the storage medium 40 if so desired.

Figure 2 is a flow chart illustrating the steps for generating and storing a motif which is used to produce a ringing tone. As shown, an initiation signal is provided to the motif generation software 44, in response to the user activating the switch 32 to start the generation process 100 at step 102. The motif generation software 44 generates a motif or a sequence of notes at step 110, wherein each note has a pitch and a duration. The assignment of the pitch and duration to each note is carried out in a random fashion, as described in conjunction with Figure 3. The assigned pitch and duration of each note is modified according to a plurality of modification rules at step 120. The modification rules, according to the Mecano-style, are described in conjunction with Figure 4, which is broken into Figures 4a - 4g because of the length of the computer program. Preferably, after the motif is generated and modified, it is output to the sound producing device 54 in

a repeating manner in order to produce a ringing tone at step 130. Preferably, the ringing tone produced at step 140 is played to the user so as to allow the user to determine whether he or she likes the ringing tone at step 140. If the user likes the ringing tone produced from the motif, the motif can be stored in the storage medium 40 at step 150 for later use. Otherwise the generated motif is discarded. The generation process 100 can be repeated if the user wishes to generate a plurality of ringing tones.

Figure 3 is a flow chart illustrating the steps for generating a motif by the motif generation software 44. At step 112, the software 44 randomly selects the length of the motif in terms of number of notes. Preferably, the number of notes in a motif ranges from 2 to 7. However, a number of notes in the motif can be greater than 7. The motif length selection step can be identified in Figure 4 by the statement

motilen=random.randint(2, 7).

At step 114, the pitch of each note in the motif is randomly assigned within a range of 24 pitch values, representing 24 semi-tones of the diatonic scale. This range is equivalent to the 24 keys (black and white) in two octaves on a piano, for example. The lowest pitch of this range can be the center C key of the piano or any other key. The range of pitches can be shortened or lengthened, if so desired. The pitch assignment step can be identified in Figure 4 by the following routine:

for n in range (motilen):

motitem = random.randint (0, 24)

motive.insert (0, motitem).

At step 116, the duration of each note in the motif is randomly assigned, preferably within a range of four note values: 1/16, dotted 1/16, 1/8 and 1/4. These note values are represented by four numbers: 24, 36, 48 and 96, respectively. It should be noted that the range of note durations can be shortened to two or three, or lengthened to five or more.

The duration assignment step can be identified in Figure 4 by the following routine:

for n in range (motilen) :
motitem = random.randint (0, 6)
if motitem = 0 : rhythmo.insert (0, 48)
if motitem = 1 : rhythmo.insert (0, 96)
5 *if motitem = 2 : rhythmo.insert (0, 36)*
if motitem > 2 : rhythmo.insert (0, 24)

Because the motif length, the pitch for each note in the motif, and the duration of each note in the motif are randomly selected or assigned, one generated sequence of notes
10 is very unlikely to be identical to another generated sequence of notes. The melodic and rhythmic variations in the motif, as generated in steps 112, 114 and 116, are in the hundreds, as are the melodic and rhythmic variations in the ringing tone.

In order to make the ringing tone sounds more natural and more pleasing, the motif generated in steps 112, 114 and 116 is modified according to a plurality of Mecano-
15 style modification rules as described below:

A) non-mechanical playing - for each note, introducing a small, random correction of the duration. That is, the duration for each note in the generated motif is slightly shortened or lengthened in a random fashion (the algorithm for this rule can be identified in Figure 4 by the **nonmechanizer** routine, where the random value for duration
20 correction ranges from -3 to 14);

B) non-legato playing - shortening the duration of each note by a fixed amount (the algorithm for this rule can be identified in Figure 4 by the routine $startp=startp+(rhyth/2)$, $duratio=rhythmo\{(n+1)\%motilen\}/2..$, where $startp$ represents the start-point of a note from the preceding note);

25 C) white keys only - eliminating the pitches that are correspondent to the black keys on a piano (the algorithm for this rule can be identified by the **diatonicer** routine in Figure 4, wherein a pitch na is replaced by $na-1$ if $na\%12$ is equal to 3, 1, 6, 8 or 10);

D) removal of identical pitches - preventing two adjacent notes within one motif or within adjacent motives from having the same pitch (the algorithm for this rule can be
30 identified in Figure 4 by the **motiverulelessamenes** routine);

E) toner internal correction- changing the pitch of a note in the motif if the tonal

interval between adjacent notes is a tritone or a seventh (the algorithm for this rule can be identified in Figure 4 by the **motiverules** routine, wherein the pitch *nb* of a note is replaced by *nb+1* if the difference between *nb* and the pitch *na* of the preceding note is equal to -6, 6, -10, 10, -11 or 11);.

5 F) trills - converting a note into a series of trills if the note value of the note is equal to or greater than a pre-determined note value (the algorithm for this rule can be identified in Figure 4 by the **motivetrills** routine, where a pitch *na* of a note is replaced by a series of alternating pitches if *na=96*); and

10 G) motif transformation - a subtle linear change in the pitches of the notes located at certain locations in the motif (the algorithm for this rule can be identified by the **transformation** routine in Figure 4).

Preferably, the modification rules are selectable in that the user can choose one or more rules to modify a motif, if so desired.

15 After the sequence is generated, the pitch and the duration are assigned to become a motif of musical tones, and the motif is modified. The modified motif is treated as a string of data to be conveyed to the sound-producing device 54 in order to produce a ringing tone. The conversion of data stream to musical tones in accordance with a certain protocol is well known in the art. For example, notes as played by buzzer, MIDI or some other output-method can be specified by a limited set of parameters. The essential
20 parameters for producing a sequence of musical tones include the start-point (*startp*, the time to start a note from the immediately previous note), the pitch (*pitch*) and the duration (*duratio*).

Figure 4 is an exemplary computer program for generating a motif in the Mecano-style. It should be noted that the computer program and the routines contained therein can
25 be modified, and the Mecano-style modification rules can be added or deleted without departing from the objective of the present invention, which is to make the ringing tones sound more natural. Furthermore, the range of the motif length, the ranges of the pitch and duration to be assigned to each note, the range of the duration correction in non-legato playing and non-mechanical playing, and the pre-determined note value for trill
30 conversion can be altered without changing the scope of the present invention.

Thus, although the invention has been described with respect to a preferred

embodiment thereof, it will be understood by those skilled in the art that the foregoing and various other changes, omissions and deviations in the form and detail thereof may be made without departing from the spirit and scope of this invention.

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